Water flow data key to pinpointing change

● A new flow data method which compares flow pattern distributions has been trialled in water companies in The Netherlands to identify changes in demand and help establish the reasons for these changes. **PETER VAN THIENEN, JAN VREEBURG** and **HENK DE KATER** discuss the method and how it can be used to monitor leakage and unregistered changes in network operation.

Monitoring district metered area (DMA) inflow data provides information about changes in demand and leakage. Traditionally, night flow data is considered the most informative for leakage detection. With the introduction of the Comparison of Flow Pattern Distributions (CFPD) method, data from a whole 24-hour period can be used in a more general, simpler, and broader way. This data-driven method identifies and quantifies distinct types of changes in the flow data, which can be attributed to specific mechanisms. These include potentially important issues such as new leakage, unregistered changes in valve status, or significant changes in demand patterns of major (industrial) customers. The method has been successfully applied in several projects at Dutch water companies.

Data analysis

The CFPD procedure[1,2] (Figure 1) compares raw flow data between two periods for a DMA or other type of supply area with a minimum size of about 50 connections. The flow data do not have to be in the same time or interval format: a data set of two weeks with a five-minute interval may be compared to a period of six weeks with an hour's interval. Unlike the commonly-used minimum night flow method, which only looks at a single moment in the entire day pattern, a comparison of the complete dataset is performed. The method is completely data-driven (no models and associated assumptions) and identifies and quantifies two different types of changes in the supply to the DMA.

The first type, consistent changes, can be attributed mainly to changes in population size, weather, and network operations. This roughly means that the pattern stays the same, but the total demand is scaled. The second type, inconsistent changes, can be related to large volume customers, weather, network configuration and leakage (either new or repaired). In this case, the pattern is shifted. Readily available or easily obtainable information about the population size (migration, holiday periods), weather and network operations (valves, leakages, large volume customer demands) form the basis for interpretation. When consistent changes are observed, they can either be explained by these known factors or indicate a possible unregistered change in the network configuration (valve status). Observed inconsistent changes can either be explained by these known factors or indicate new, unknown leakage or unregistered changes in network configuration. In this way, valuable additional knowledge can be obtained from data which is registered by every water company.

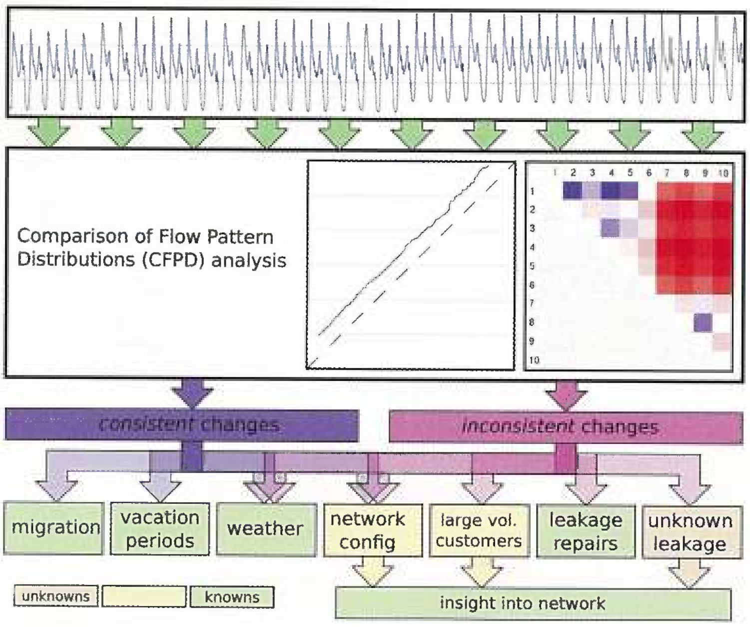

Figure 1: CFPD analysis of DMA inflow data with discriminative interpretation results in an increased insight into the operation of a distribution network

About the authors

Peter van Thienen, Senior Scientific Researcher, KWR Watercycle Research Institute, Nieuwegein, The Netherlands. Email: peter.vanthienen@kwrwater.nl

Jan Vreeburg, Principal Researcher, KWR Watercycle Research Institute, Nieuwegein, The Netherlands. Email: jan.vreeburg@kwrwater.nl

Henk de Kater, Senior Advisor Infrastructure, Evides Waterbedrijf, Rotterdam, The Netherlands. Email: h.dekater@evides.nl

The method in practice

In the past year, the CFPD method has been applied at several Dutch drinking water companies to assess its value for practical application. For Evides Waterbedrijf an analysis was performed for two neighbouring supply areas. As in many Dutch supply areas the background leakage is very low. For the first DMA a comparison of the analysis results to a list of registered incidents, including but not limited to leakage, was made. Several incidents were recovered in the analyses, but several were not, presumably because the incidents were not pipe leaks or their flow rate was too small. Unexpectedly, an inconsistent deviation lasting several months was also found that was not apparent from the water balance.

The CFPD analysis of the second, adjacent DMA was targeted at unexplained deviations in its water balance. Almost all inconsistent changes could be attributed to operational actions, but interestingly the deviation from this second DMA matched the deviation observed in the first DMA but in an opposite manner, with no known relation to the network's operation. This led to the identification of an open connection between the neighbouring supply areas, which was supposed to be closed. Only after 600,000m^3 of water had flown from one area to the next, significantly affecting the water balance of both, was the valve closed. More importantly, it resolved the potentially dangerous situation of unknown valve status.

This experience demonstrates the power of the CFPD method in increasing the understanding of the dynamics of supply areas, not only in terms of leakage, but also in terms of network configuration and operation. ●

References

[1] *van Thienen, P (2013), A method for quantitative discrimination in flow pattern evolution of water distribution supply areas with interpretation in terms of demand and leakage. Journal of Hydroinformatics, Vol 15, No 1, pp86-102.*

[2] *van Thienen, P, Pieterse-Quirijns, I, Vreeburg, J, Vangeel, K and Kapelan, Z (2013), Applications of discriminative flow pattern analysis using the CFPD method. Accepted for publication in Water Science and Technology – Water Supply.*